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EFFECT OF AGE OF CRUSHER SCREEN ON PROPERTIES OF CONCRETE

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ABSTRACT

The purpose of this study is to know the effects of coarse aggregate on the properties of concrete with the change in age of crusher screen. Location selected for the study purpose has been limited to Durg district of Chhattisgarh region. Two numbers of quarries have been selected having lime stone as a major source. Samples from both the quarries have been collected keeping in mind the age of screen age of crushers of that particular area. The study investigates various test that has been conducted on the samples collected from the selected quarries. Using the same make of cement, mix design has been prepared with the sample collected after getting their specific gravity and the water cement ratio has been kept same for both the mix design. The test like slump and compressive strength were performed. The grade of concrete considered for this study purpose is M20. It is found that as the age of aggregate crusher screen increases from 0-2 years, 2-4 years, 4-6 years and more than 6 years the fineness modulus increases it shows that older the crusher screen, the average particle size of coarse aggregates increases. The study resulted – though the age of crusher screen increases the workability decreases as well as the compressive strength also decreases but without affecting the target mean strength.

KEYWORDS: Analytical Study, Fine and Coarse Aggregate, Sieve Analysis

INTRODUCTION

Concrete is a composite material composed of coarse granular material (the aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space among the aggregate particles and glues them together. The performance of concrete depends on the quality of the ingredients, their proportions, placement, and exposure conditions. In the fabrication of concrete, amount and the type of cement, fine and coarse aggregate, water, temperature of mixing, admixture, and the environment to which it is exposed will determine its physical, chemical, and durability behavior. Various analytical techniques are applied to study the effect of these parameters and for quality control purposes.

Objectives of the Study

Here the main objective is to consider the age of crusher screen and it has been divided into different segments on the basis of the age of crusher screen".

- Identification of crusher screen age wise.
- Location of aggregates collected.
- For two locations one in Durg (Nandini quarry) and other in Bhilai (salood).
- To find the specific gravity of aggregate for both the locations.
- Know the water absorption for both fine and coarse aggregate and coarse aggregates.
- Two Mix designs for the concrete for M20 grade of concrete.

- Analytical study.

Scope of Work

As a result by considering all the properties of concrete like gradation of aggregate,(sieve analysis), type of cement, slump test, compressive strength test, compaction factor test of concrete.

Following the above procedures and depending on the age of crusher screen comparative study shall be done to know the affect of age of crusher screen on properties of concrete.

Importance of Study

The significance of the study is to know how the size and shape of the coarse aggregates influence the properties of concrete when the quarries and crushers are changed keeping the size of aggregates and grade of concrete same and also whether it affects the properties of concrete such as workability, durability and its strength

HYPOTHESIS

Hypothetically the result shall lead to the following conclusions:

- If the sources of aggregates are different as well as the type of aggregates (lime, quartzite, basalt etc.) changes, it shall affect the durability of the concrete.
- For the same region the aggregates reaching the site from two different quarries their physical as well as mechanical properties may differ.
- If the aggregates reaching the site are from the same quarry but crushers are different and the age of the crusher screen is also varying it may effect on the gradation of the aggregate as well as shape and texture of the aggregates.
- Due to change in size and shape of the aggregates, the workability of the concrete may change.
- The higher age of crusher screen leads to expansion of holes in the crusher screen by which at the time of concreting for the same mix design more voids shall occur in the concrete due to improper gradation of aggregates and also due to the ignorance of proper compaction during casting shall tend to create the gaps between the aggregate.
- The characteristic compressive strength required for the structure will also tend to change with a change in the properties of aggregates which is considered as most important property regarding strength of any civil structure.

RESEARCH METHODOLOGY

Testing's shall be executed in the laboratory. Samplings play a significant role as good samples are required. In preparing these samples, few important steps shall be taken into account, among others:

- Selection of concrete grade
- Concrete mix design
- Raw materials
- Measuring and mixing of concrete

- Concrete Performance test

Selection of Concrete Grade

As per IS-456-2000, minimum grade of concrete Mix is M20, this study confines to M20 grade of concrete because it is the basic concrete grade required for residential, commercial, high-rise buildings, etc. and in course of study on grade M20 as per the hypothesis if we get the desired results further study shall be carried out. This research shall concentrate on M20 grade of concrete.

Selection of Location

As discussed earlier it has been found that types of aggregates are formed due to formation of various types of rocks, depending on the location where they are found, for example lime, basalt, quartzite etc. the whole study is limited to Chhattisgarh region of India specifically at Durg and Bhilai. At these locations aggregates found are of **lime stone.** Thus samples collected are of lime stone aggregates

Selection of Quarry

At the above mentioned location there are limited numbers of quarries which are the major source of lime stone aggregates for concrete mix. Two quarries that has been selected here for the study purpose are **Salood and Nandini mines**

Selection of Crushers

Since the concept of this study is being on aggregate crusher screen, aggregates depending on the age of the crushers screen of that selected crusher is taken into consideration. Here the age of crusher means the time of installation of crusher screen. The two sites that are selected here from where the samples are collected, the age of crusher screen considered is as follows: Crusher screen age – 0 to 2 years

Crusher screen age – 2 to 4 years

Crusher screen age – 4 to 6 years

Crusher screen age – more than 6 years.

Nomenclature of Samples Collected

Location of Crusher – Salood Mines

LS1 – lime stone1 (sample of crusher screen age having 0 to 2 years)

LS2 – lime stone2 (sample of crusher screen age having 2 to 4 years.)

LS3 – lime stone3 (sample of crusher screen age having 4 to 6 years)

LS4 – lime stone4 (sample of crusher screen age having more than 6 years)

Location of Crusher – Nandini Mines

LS5 – lime stone5 (sample of crusher screen age having 0 to 2 years)

LS6 – lime stone6 (sample of crusher screen age having 2 to 4 years.)

LS7 – lime stone7 (sample of crusher screen age having 4 to 6 years)

LS8 – lime stone8 (sample of crusher screen age having more than 6 years)

Sieve Analysis-The test sieve used for concrete aggregate have square openings and their properties are prescribed by BS 410: 1986 and ASTM E 11- 87.

Requirements of Grading-The strength of full compacted concrete with a given water/cement ratio is independent of the grading of the aggregate, grading is, in the first instance, of importance only in so far as it affects its workability. The main factors governing the desired aggregate grading are the surface area of the aggregate, which determine the amount of water necessary to wet all the solids; the relative volume occupied by the aggregate; the workability of the mix; and the tendency to segregation. The practical problem is that aggregate from different sources, even if nominally of the same grading vary in the actual distribution of particle size within a given size fraction, as well as in other properties of the particles such as shape and texture. It has to be added the total volume of voids in concrete is reduced when the range of particle sizes from the maximum size downward is as large as possible.

Specific Gravity and Water Absorption of Fine Aggregate -The specific gravity of fine aggregate is determined as per the procedure specified in I.S.2386 (Part III): 1963, (reaffirmed: 1997). Method - III of clause 2.4.2.1.

Concrete Mix Design- In this research the method adopted for mix design is newly adopted method of IS 10262: 2009. The detailed procedure is described with analysis, experimental work done in the laboratory.

Slump Test-This is a test used extensively in the site work all over the world. The slump test is prescribed by ASTM C 143 – 90a and BS 1881: Part 102: 1983.

EXPERIMENTAL WORK

The whole experimental work was carried out in the concrete lab of Bhilai institute of technology, Durg using the basic ingredients of concrete –coarse aggregate, fine aggregate water and cement.

- **Coarse Aggregates** –as we have discussed earlier that two quarries were selected namely Salood mines and Nandini mines, which are consisting of natural crushed rock of nominal maximum size 20 mm, from different crushers as per there age of aggregates crushing screen for both the mines. The name used in this study is LG which stands for lime stone (as both the quarries are of lime stones) and then the number has been given as per there crusher screen age which is again mentioned below-

  For Salood Quarry: aggregates samples of different age of crusher screen

  LS1 – Age of crusher screen between 0 to 2 years

  LS2 – Age of crusher screen between 2 to 4 years

  LS3 – Age of crusher screen between 4 to 6 years

  LS4 – Age of crusher screen more than 6 years

  For Nandini Quarry

  LS5 – Age of crusher screen between 0 to 2 years

  LS6 – Age of crusher screen between 2 to 4 years

  LS7 – Age of crusher screen between 4 to 6 years

  LS8 – Age of crusher screen between more than 6 years

- **Fine Aggregate:** The fine aggregate used for the experimental work as supplied for the construction site consisting of natural sand from Tandula River.
- **Cement:** Portland slag cement, confirming to IS: 456: 1989 of ACC slag cement.

Specific Gravity and Water Absorption of Fine Aggregate

The specific gravity and water absorption of fine aggregate is determined as per the procedure specified in IS 2386: 1963. (Reaffirmed 1997) Method III of clause 2.4.2.1.

Specific gravity**= 2.571**

Water absorption **= 1.2 %**

Fineness Modulus of Fine Aggregate

Table 1: Fineness Modulus of Sand (F.A.) Weight of Sample Taken = 1 kg (1000 gm)

I.S. Sieve Size	Weight Retained (in gm.)	Cumulative Weight Retained (in gm)	Cumulative % Retained	Cumulative % Passing
80 mm	-	-	-	-
40 mm	-	-	-	-
20 mm	-	-	-	-
10 mm	0	0	0	-100.00
4.75 mm	11	11	1.10	98.9
2.36 mm	63	74	7.40	92.60
1.18 mm	141	215	21.50	78.50
600 micron	243	460	46.00	54.00
300 micron	214	674	67/40	32.60
150 micron	326	1000	100	0.00
Below 150 micron				
Total	**1000**		**243**	

Table 2: Fineness Modulus of Fine Aggregate = 243 /100 = 2.43 Grading Zone – as per IS 383 of Table - 4 Zone – IV Coarse Aggregates

Name of Quarry	Samples	Fineness Modulus	Specific Gravity	Water Absorption
Salood quarry	LS1	7.56	2.542	0.65
	LS2	7.38	2.462	0.70
	LS3	7.80	2.472	0.75
	LS4	7.84	2.477	0.65
Nandini quarry	LS5	7.50	2.64	1.05
	LS6	7.29	2.65	0.90
	LS7	7.80	2.59	1.98
	LS8	7.80	2.58	1.40

Concrete Mix Design-The concrete mix design will be done for both the quarry sample. Here first we will do the concrete mix design for the Salood quarry samples. As the specific gravity, water absorption is on the mean basis so the design stipulations are as follow.

Salood Quarry: Stipulations for Design

- Grade of concrete = M20
- Cement type = Portland slag cement (I.S.455: 1989) (ACC cement)

- Specific gravity of cement = 2.90
- Nominal max. size of coarse aggregate = 20mm
- Specific gravity of coarse aggregate = 2.465
- Type of fine aggregate = river sand
- Workability desired = 25 to 50 mm
- Type of exposure = mild

Now the concrete mix design for the above mentioned stipulations as per I.S. 10262 – 2009, will be as follow for concrete grade M20.

Target mean strength $f_{ck} = f_{ck} + 1.5\ S$

Table No. 1 from I.S. 10262- 2009 - M20

$S = 4.0\ N/mm^2$

$f_{ck} = 20 + (1.65 \times 4.00)\ N/mm^2 = 26\ N/mm^2$

Water cement ratio = taking water cement ratio as per I.S. 456 Table no. 5 = 0.55

Selection of water content – as per I.S. 10262 -2009 from table 2 maximum water content for 20mm size of aggregate = 186 liters.

Cement content = water content / water cement ratio

$= 186 / 0.55 = 338.18\ kg / m^3$

Proportion of volume of coarse aggregate and Fine aggregate (as per I.S. 10262-2009 Table 3).

For 20 mm max. size of coarse aggregate, water cement ratio = 0.5 and Zone II of fine aggregate, volume of coarse aggregate per unit volume of total aggregate is 0.62.

This is to be suitably adjusted for increase in water cement ratio from 0.50 to o.60 @ ± 0.01 for each 0.05 difference in water cement ratio.

Hence volume of Coarse aggregate per unit volume of total aggregate

$= 0.62 – 0.01 = 0.61$

Therefore volume of fine aggregate per unit volume of total aggregate

$= 1.00 – 0.61 = 0.39$

Mix Proportion Obtained

Free water content = 186.00 ltr.

Cement content = 338 kg.

Fine aggregate = 681 kg.

Coarse aggregate = 1066 kg.

Net free water cement ratio = 186 / 338 = **0.55**

Hence the trial mix proportion by mass is 338: 681: 1066 or **1: 2: 3.15** with water cement ratio of 0.55.

Nandini Quarry: Stipulations for Design

- Grade of concrete = M20
- Cement type = Portland slag cement (I.S.455: 1989) (ACC cement)
- Specific gravity of cement = 3.1
- Nominal max. size of coarse aggregate = 20mm
- Specific gravity of coarse aggregate = 2.62
- Type of fine aggregate = river sand
- Workability desired = 25 to 50 mm
- Type of exposure = mild

Now the concrete mix design for the above mentioned stipulations as per I.S. 10262 – 2009, will be as follow for concrete grade M20.

Target mean strength $f_{ck} = f_{ck} + 1.5\ S$

Table No. 1 from I.S. 10262- 2009 M20

$S = 4.0\ N/mm^2$

$f_{ck} = 20 + (1.65 \times 4.00)\ N/mm^2 = 26\ N/mm^2$

Water cement ratio = taking water cement ratio as per I.S. 456 Table no. 5 = 0.55

Selection of water content – as per I.S. 10262 -2009 from table 2 maximum water content for 20mm size of aggregate = 186 liters.

Cement content = water content / water cement ratio

$= 186 / 0.55 = 338.18\ kg / m^3$

Proportion of Volume of Coarse Aggregate and Fine Aggregate (as per I.S. 10262-2009 Table-3)

For 20 mm max. size of coarse aggregate, water cement ratio = 0.5 and Zone II of fine aggregate, volume of coarse aggregate per unit volume of total aggregate is 0.62.

This is to be suitably adjusted for increase in water cement ratio from 0.50 to o.60 @ ± 0.01 for each 0.05 difference in water cement ratio.

Hence volume of Coarse aggregate per unit volume of total aggregate

$= 0.62 – 0.01 = 0.61$

Therefore volume of fine aggregate per unit volume of total aggregate

$= 1.00 – 0.61 = 0.39$

Mix Proportion Obtained

Free water content = 186.00 ltr.

Cement content = 338 kg.

Fine aggregate = 688 kg.

Coarse aggregate = 1145 kg.

Net free water cement ratio = 186 / 338 = 0.55

Hence the trial mix proportion by mass **is 338: 688: 1145 or 1 : 2.04 :3.38** with water cement ratio of 0.55.

Table 3: Slump Test for Salood Quarry Concrete Mix

S. No.	Sample	Slump
1	LS1	35 mm
2	LS2	45 mm
3	LS3	32 mm
4	LS4	25 mm

Table 4: Slump Results for Nandini Quarry Concrete Mix

S. No.	Sample	Slump
1	LS5	40 mm
2	LS6	30 mm
3	LS7	40 mm
4	LS8	20 mm

Table 5: Compaction Factor Result of Salood Quarry

S. No.	Sample	Compaction Factor
1	LS5	0.90
2	LS6	0.915
3	LS7	0.890
4	LS8	0.92

Table 6: Compaction Factor Result of Nandini Quarry

S. No.	Sample	Compaction Factor
1	LS6	0.92
2	LS7	0.93
3	LS8	0.931
4	LS9	0.915

Table 7: 7 Days Compressive Strength of Salood Quarry Concrete Mix

S. No.	Sample	Age of Testing	Compressive Strength in N /mm^2
1	LS1	7 Days	14.45 N /mm^2
2	LS2	7 Days	13.33 N /mm^2
3	LS3	7 Days	14.89 N /mm^2
4	LS4	7 Days	14.89 N /mm^2

Table 8: 14 Days Compressive Strength of Salood Quarry Concrete Mix

S. No.	Sample	Age of Testing	Compressive Strength in N /mm^2
1	LS1	14 Days	19.99 N /mm^2
2	LS2	14 Days	19.33 N /mm^2
3	LS3	14 Days	20.89 N /mm^2
4	LS4	14 Days	19.78 N /mm^2

Table 9: 28 Days Compressive Strength of Salood Quarry Concrete Mix

S. No.	Sample	Age of Testing	Compressive Strength in N /mm^2
1	LS1	28 Days	27.33 N /mm^2
2	LS2	28 Days	30.89 N /mm^2
3	LS3	28 Days	27.11 N /mm^2
4	LS4	26 Days	32.45 N /mm^2

Compressive Strength Test Result for Nandini Quarry Concrete Mix

Table 10: 7 Days Compressive Strength of Nandini Quarry Concrete Mix

S. No.	Sample	Age of Testing	Compressive Strength in N /mm^2
1	LS5	7 Days	15.74 N /mm^2
2	LS6	7 Days	16.55 N /mm^2
3	LS7	7 Days	13.64 N /mm^2
4	LS8	7 Days	13.72 N /mm^2

Table 11: 14 Days Compressive Strength of Nandini Quarry Concrete Mix

S. No.	Sample	Age of Testing	Compressive Strength in N /mm^2
1	LS5	14 Days	21.78 N /mm^2
2	LS6	14 Days	24.00 N /mm^2
3	LS7	14 Days	18.89 N /mm^2
4	LS8	14 Days	18.23 N /mm^2

Table 12: 28 Days Compressive Strength of Nandini Quarry Concrete Mix

S. No.	Sample	Age of Testing	Compressive Strength in N /mm^2
1	LS5	28 Days	28.11 N /mm^2
2	LS6	28 Days	25.75 N /mm^2
3	LS7	28 Days	27.11 N /mm^2
4	LS8	26 Days	25.78 N /mm^2

ANALYSIS OF WORK

In the course of this study we have considered specific gravity of coarse aggregates, fineness modulus, durability of concrete, compaction factor, slump and the compressive strength of the concrete, also taken into consideration the age of aggregate crusher screen in order to understand its impact on properties of concrete, for which the locations selected are Salood and Nandini quarries at dist. Durg, Chhattisgarh.

Since we have chosen two locations we shall do the comparative analysis of the above factors that has been considered in the study using chart and graphs

Analysis of Slump

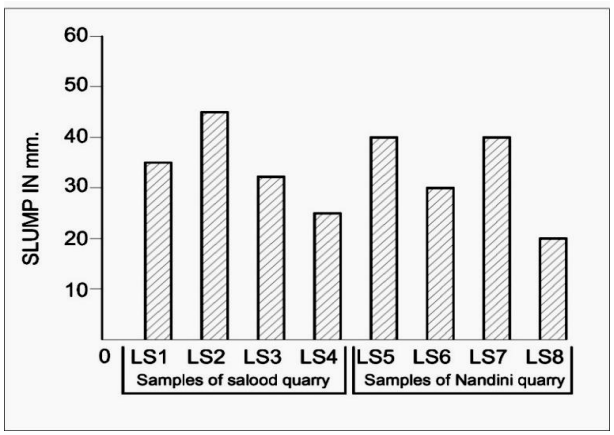

Figure 1: Chart for Slump of Salood and Nandini Quarry Concrete

Conclusion for slump-from the above chart for two locations of quarry the slump chart is drawn and it's clear, as the age of aggregate crusher screen increases the slump of concrete decreases. During the concrete mix design here the slump is considered from 25 to 50 mm, hence for more slumps for the same water cement ratio the age of crusher screen affects the workability of concrete.

In between for the same concrete mix design slump for concrete is near about same or irregular but after as the age of crusher screen more than 6 years slump has been considerably decreased, therefore the age of screen has decremented affect on workability of concrete.

Fineness Modulus of Aggregate

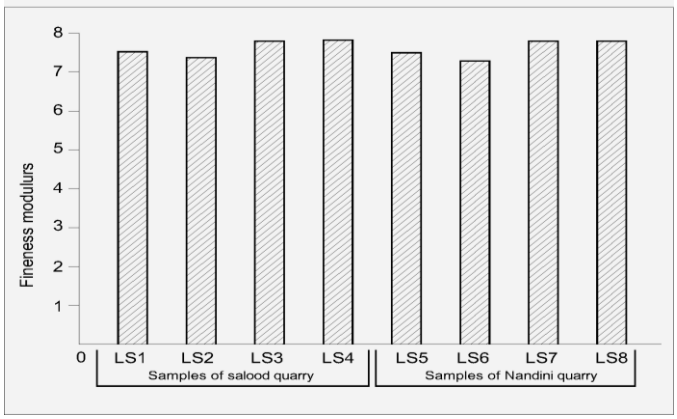

Figure 2: Chart of Fineness Modulus for Salood and Nandini Quarry Aggregates

Hence the fineness modulus of the coarse aggregate cannot be used as a single description of the grading of an aggregate, but it is valuable for measuring slight variations in the aggregate from the same source, within the certain limitations, the fineness modulus gives an indication of the probable behavior of a concrete mix made with aggregate having a certain grading and the use of the fineness modulus in assessment of aggregates and in mix proportioning has many supporters..

From the above figure it is clear as the age of the crusher screen increases the average aggregates particle sizes also increases and it affects somehow on the compressive strength of the concrete mix.

Compaction Factor for Concrete Mix

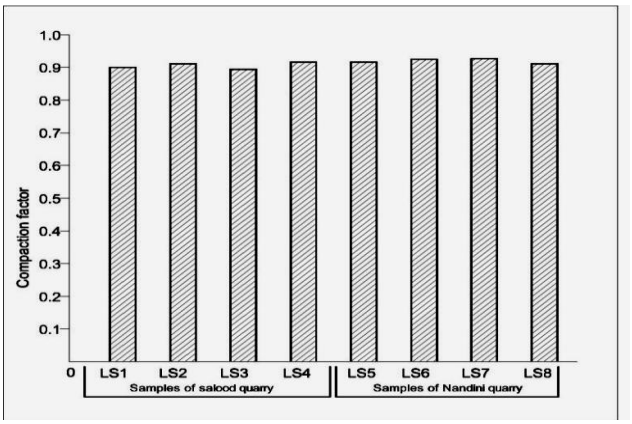

Figure 3: Chart of Compaction Factor for Salood and Nandini Quarry Concrete Mix

The degree of compaction, called the compaction factor, is measured by density ratio i.e. the ratio of density actually achieved in the test to the density of the same concrete fully compacted.

For normal range of concrete the compacting factor lies between 0.82 – 0.92, and for both location in the study, from the figure it's very clear the values of compaction factor are between the required range, so all the above results are showing for the good workable concrete but as far as slump, as we have seen previously they are not as per the desired workability, so from this study as it seems that here not the desirable results for the workability of concrete, if only the compaction factor is considered.

Compressive Strength Results

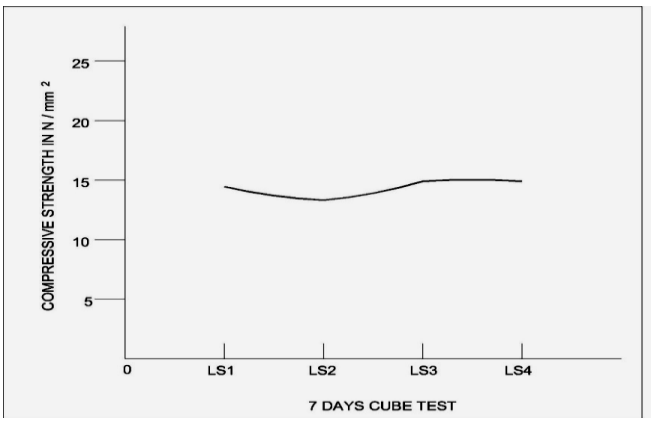

Figure 4: Plot of 7 Days Compressive Strength for Salood Concrete Sample

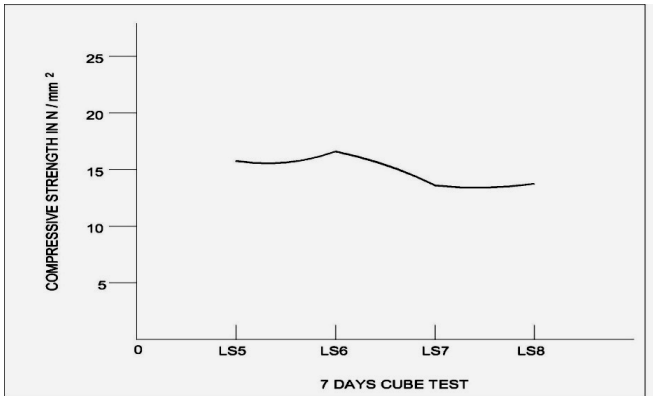

Figure 5: Plot of 7 Days Compressive Strength for Nandini Concrete Sample

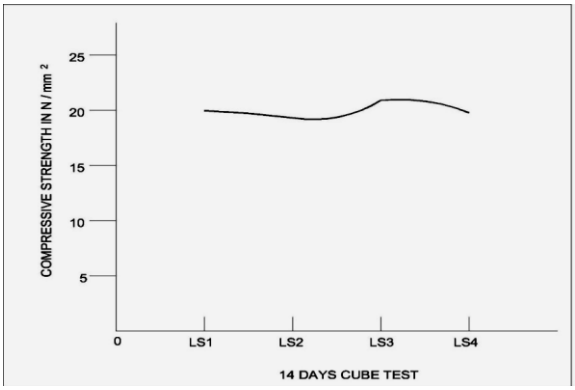

Figure 6: Plot of 14 Days Compressive Strength for Salood Concrete Sample

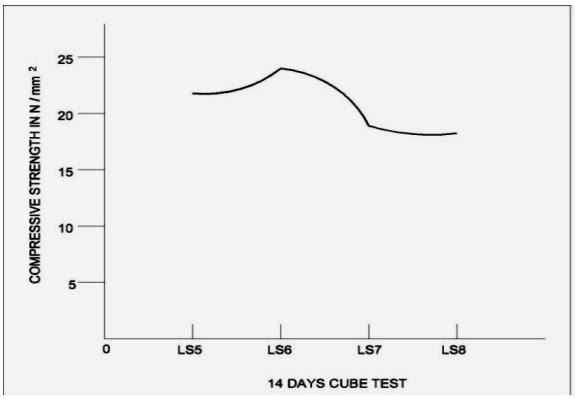

Figure 7: Plot of 14 Days Compressive Strength for Nandini Concrete Sample

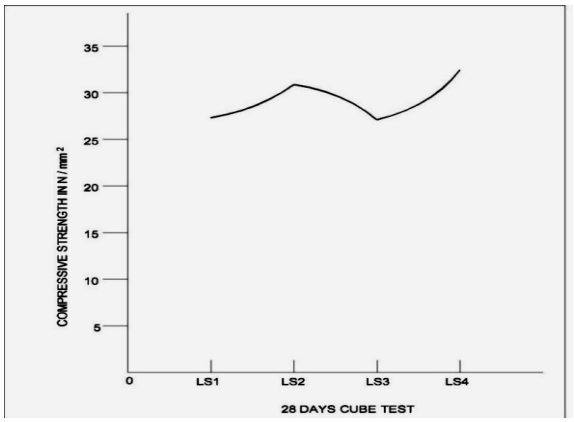

Figure 8: Plot of 28 Days Compressive Strength for Salood Concrete Sample

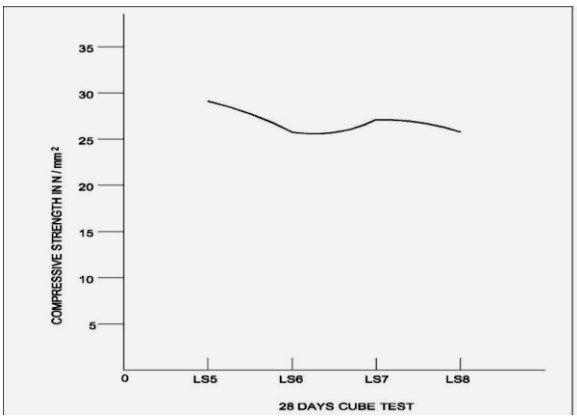

Figure 9: Plot of 28 Days Compressive Strength for Nandini Concrete Sample

As discussed in chapter I compression test is most common test conducted on hardened concrete, partially because it is an easy test to perform and partially because most of the desirable characteristics properties are qualitatively related to its compressive strength.

The duration of cube test that we have taken is for 7 days, 14 days and 28 days, which can be seen by above shown graphs. After studying these graphs for different time and for also for two different locations we found that the result obtained for compressive strength for required strength for M20 grade of concrete

Test Result 7 Days: The compressive strength is almost same or decreasing for all the samples taken.

Test Result 14 Days: The compressive strength of sample collected from both the locations is decreasing.

Test Result 28 Days: The compressive strength of sample collected from both the locations is decreasing.

CONCLUSIONS

Based on the above study following conclusions has been made:

- The samples collected from both the locations (Salood and Nandini Quarry) the aggregates are of lime stone, the specific gravity of the samples collected from Salood quarry is 2.465 and for that for Nandini quarry is 2.62 its found that the difference is very small (0.15).
- As far as slump is concerned, the results from the test conducted on all the samples collected from both the quarries as mentioned above we have found that as the age of the aggregate crusher screen increases the workability decreases. (The study shows that the crusher screens of age more than 6 years should not be used.)
- Since the normal range of concrete the compacting factor lies between 0.82 – 0.92. From the study it is found that for all samples the compaction factor lies between 0.90 to 0.92 thus we cannot provide any type of conclusions with respect to age of crusher screen and the compaction of concrete.
- From the test results of the fineness modulus for both locations we have found that as the age of aggregate crusher screen increases the average particle size of coarse aggregate also increases.
- It is mentioned in hypothesis that when the age of aggregate crusher screen increases the compressive strength decreases, the study also says that the compressive strength decreases with the change in age of crusher screen but the desirable compressive strength for M 20 (the study is done on M20 Grade) has been found in the every test result.
- By the physical observation it is found that the angularity of the aggregate particles reduced with the age of the crusher screen.

FURTHER SCOPE OF WORK

This whole study is done under some limitations like the grade of concrete is M20, the selected quarries are of same type of rock (in this research it is Lime stone), as the selected both the quarries are of lime stone as well as the fine aggregate and cement taken for both the mix designs are same.

For further study on the same topic “Effect of coarse aggregate crusher screen on properties of concrete”.

- The grade of the concrete mix design change instead of M20.

- Type of Cement can be changed.
- Source of fine aggregate can also be changed.
- Source of coarse aggregates like basalt, granite etc can be changed.
- Modulus of elasticity can be finding.
- Permeability of concrete by changing the above like source of coarse aggregate, grade of concrete, type of cement.

The comparative study may be done on the above basis.

CONTRIBUTION TO PRACTICAL FIELD

This study expects contribution to the practical field as:

- At the time of selection of aggregate, the special care shall be given for the selection of the crusher screen from where the aggregate will obtain.
- The aggregate source from where the aggregate is coming to the site physical verification should be done and the crusher whose screen age is 6 years or more than 6 years should be avoided for concrete mix.
- The proper quality control is must in the selection of aggregate as from this study it comes to know that age of crusher screen is a hidden reason which reduces the compressive strength of the concrete.
- Fineness modulus results of this study shows that average size of aggregate increased by the age of crusher screen, which demands less water for mixing but strength is reduced because of disturbed gradation.

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